Gibson & Lorenz

Comparative Tests of
Illinois Central Railroad
Locomotives No. 920 & No. 940

Railway Mechanical Engineering

B. S.

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COMPARATIVE TESTS OF ILLINOIS CENTRAL RAILROAD LOCOMOTIVES NO. 920 AND NO. 940

BY

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FREDERICK AYRES LORENZ

THESIS FOR THE DEGREE OF BACHELOR OF SCIENCE

IN RAILWAY MECHANICAL ENGINEERING

IN THE

COLLEGE OF ENGINEERING

OF THE

UNIVERSITY OF ILLINOIS

Presented June, 1909

UNIVERSITY OF ILLINOIS

June 1, 1909

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

MILES OTTO GIBSON and FREDERICK AYRES LORENZ

ENTITLED COMPARATIVE TESTS OF ILLINOIS CENTRAL RAILROAD LOCOMOTIVES No. 920 AND No. 940

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Railway Mechanical Engineering

F. W. Marquis.
Instructor in Charge.

APPROVED: Edward C. Schmidt

HEAD OF DEPARTMENT OF Railway Engineering

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ILLUSTRATIONS.

A COMPARATIVE TEST OF ENGINES 940 AND 920
ILLINOIS CENTRAL RAILROAD.

In the following pages will be found a report of a comparative test of locomotives 920 and 940 of the Illinois Central Railroad. The tests of these two locomotives lasted four days, each making a round trip between Champaign and Chicago, Illinois. For comparison the north bound run of each engine, designated as test S 1013 and test S 1017, respectively, has been chosen.

The heaviest grade going north over this section of the railroad is just before reaching Paxton, where there is a long grade of 28.9 feet per mile. See Plate VI. Ordinarily these engines handle from 2200 to 2300 tons over this grade, but for these tests, the tonnage was increased to 2850 for Engine 940, and 2670 for Engine 920, with the idea of stalling them at this point. By referring to Plate X_c, it will be seen that the 920 failed to handle its train, and made two unsuccessful attempts to get over the hill. After reaching Gilman the tonnage was reduced so that the engines could complete the run at a higher rate of speed. See Table of Summarized Data, Pages 38, 39 and 40.

OBJECT.

The test of these two locomotives was made for determining the saving if any, that could be obtained by the use of the Allfree-Hubbell valve and cylinders, instead of the piston valve and ordinary cylinders on the same class of engines.

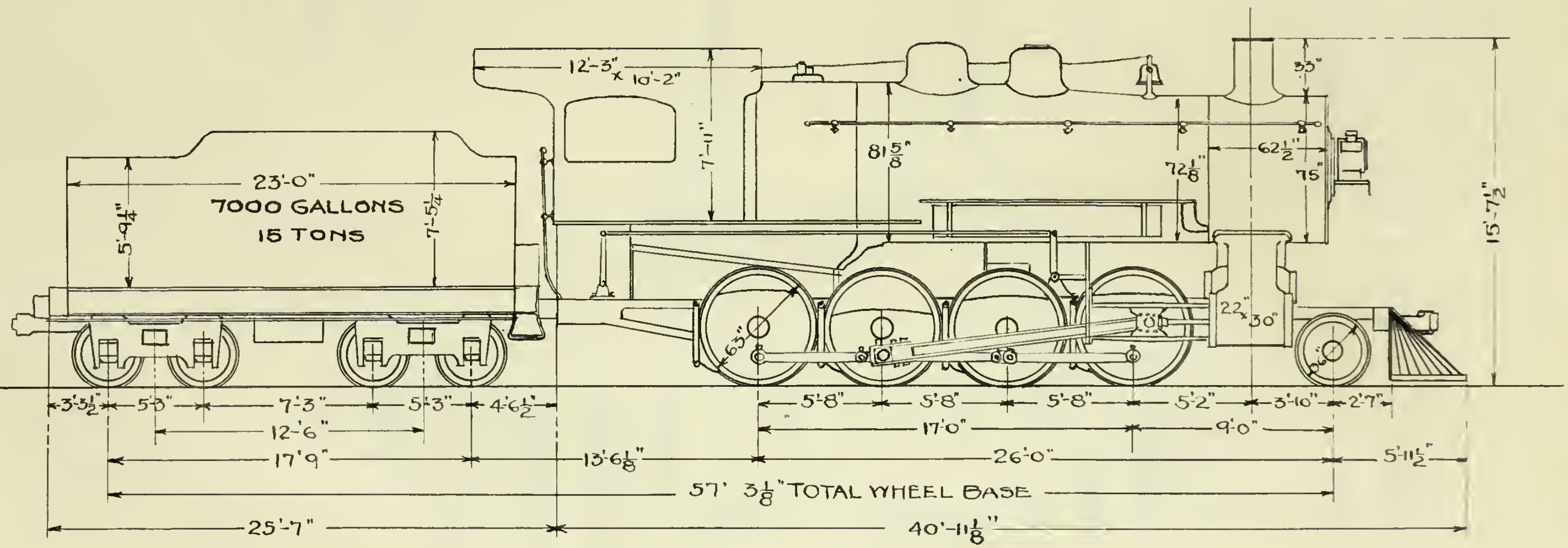
DESCRIPTION OF THE LOCOMOTIVES.

Engines 940 and 920 are of the same type and dimensions,

with the exception of cylinders and valves. Both locomotives were built by the Brooks Locomotive Company in 1907. Engine 940 is equipped with the Allfree-Hubbell valves and cylinders; the other engine being equipped with the usual piston valve and cylinders. The following table of engine dimensions and cylinder data was supplied by the Railroad Company. Plate I is an outline drawing of this class of engines.

ENGINES NUMBER 920 AND 940 ILLINOIS CENTRAL RAILROAD

BUILT BY BROOKS LOCOMOTIVE COMPANY 1907



NOTE: SEE TABLE OF BOILER AND CYLINDER DIMENSIONS

TABLE I.

ENGINE AND BOILER DATA

ENGINE NUMBER	920	940
GENERAL DIMENSIONS		
Type	2 - 8 - 0	2 - 8 - 0
Built in	1907	1907
Builder, American Locomotive Co.	Brooks	Brooks
Length over all, Engine	40' - $11\frac{1}{8}$"	40' - $11\frac{1}{8}$"
Length over all, Engine and Tender	66' - $6\frac{1}{8}$"	66' - $6\frac{1}{8}$"
Height of Center of Boiler over rail	10' - $\frac{5}{32}$"	10' - $\frac{5}{32}$"
Driving wheel-base	17' - 0"	17' - 0"
Engine wheel-base	26' - 0"	26' - 0"
Wheel-base, Engine and Tender	57' - $3\frac{1}{8}$"	57' - $3\frac{1}{8}$"
Weight on Drivers	181,000 lb.	181,000 lb.
Total weight, Engine	203,500 lb.	203,500 lb.
Weight of Tender, loaded	145,000 lb.	145,000 lb.
Capacity of Tank	7000 gal. H_2O 15 tons coal	7000 gal H_2O 15 tons coal
Diameter of Drivers, Actual	$62\frac{11}{16}$"	$62\frac{11}{16}$"
" " " , Nominal	63"	63"
Main Rod, Center to Center		

TABLE II.

ENGINE AND BOILER DATA

ENGINE NUMBER		920	940
CYLINDER DIMENSIONS			
Diameter of Cylinders, Nominal		22"	22"
" " " , Actual		$22\frac{1}{32}$"	R. Side $22\frac{1}{32}$"
			L. " $22\frac{3}{64}$"
Stroke, Piston		30"	30"
Diameter of Piston Rod		4"	4"
Clearance of Cylinders %	Right Side, H'd End	9.55	3.35
	Right Side, C'K End	6.5	3.19
	Left Side, H'd End	7.86	3.28
	Left Side, C'K End	7.88	3.68
Diameter of Piston Valve		12"	
Valves, Kind		Piston	Allfree-Hubbell
Greatest Valve Travel		$5\frac{13}{16}$"	6"
Outside Lap		1"	$1\frac{1}{8}$"
Inside Lap		0	$\frac{7}{16}$"
Valve Lead, in Full Gear		$\frac{1}{32}$"	$\frac{1}{32}$"

TABLE III.

ENGINE AND BOILER DATA

ENGINE NUMBER	920	940
BOILER DIMENSIONS		
Type of Boiler	Extended Wagon Top	Extended Wagon Top
Firebox - Length(inside)	107"	107"
Firebox - Width (inside)	$67\frac{1}{4}$"	$67\frac{1}{4}$"
No arch in firebox		
Greatest Internal Diameter of Stack	18"	18"
Least " " " "	18"	18"
Kind of Exhaust Nozzle	Single	Single
Diameter of Exhaust Nozzle	$5\frac{1}{8}$"*	5"
Distance from Tip of Exhaust Valve to Center of Boiler	$5\frac{7}{8}$"	$5\frac{7}{8}$"
Working Steam Pressure	200 lb./sq.in.	200 lb/sq.in.
Area of Flue Heating Surface	2,769.3 sq.ft.	2,769.3 sq.ft.
Area of Firebox Heating Surface	177.0 sq.ft.	177.0 sq.ft.
Total Heating Surface	2,946.3 sq.ft.	2,946.3 sq.ft.
Area of Grate Surface	50 sq.ft.	50 sq.ft.
Number of Tubes	344	344
Outside Diameter of Tubes	2"	2"
Length over Sheets	15' - 6"	15' - 6"

*This nozzle has a bridge 1/2" wide, which comes flush with top of tip.

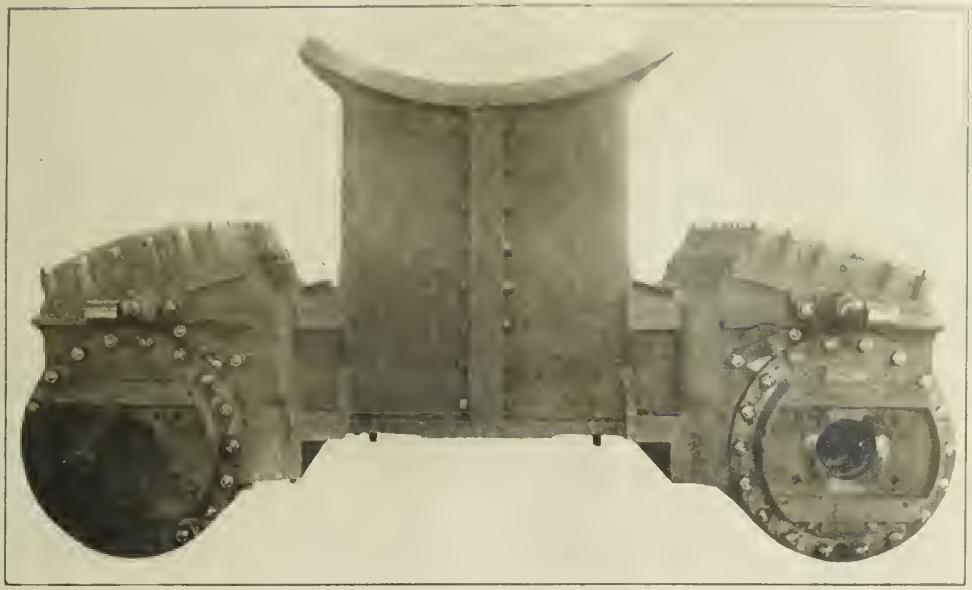
DESCRIPTION OF THE ALLFREE-HUBBELL VALVE.

The difference between the steam distribution of the two engines lies principally in the fact that with the Allfree-Hubbell valves, the point of both exhaust opening and closure is later in the stroke, and that the opening for the exhaust steam is larger, allowing the cylinders to very rapidly free themselves. There are also other differences in the cylinder which undoubtedly had an effect upon the steam economy obtained, such as, much shorter ports, the separation of the live and exhaust steam passages in the cylinder casting, the polished surface of ports, piston and cylinder heads, and the insulation of the steam chest cover as shown by Figure 2, Plate II.

The earlier designs of the Allfree-Hubbell valve gear employed the use of a general sector operated from the cross-head, which had a supplementary effect upon the movement of the valve proper, by means of an eccentric connection at the rocker arm. In the latest design, however, this outside attachment has been eliminated, and the valve is connected directly to the valve steam, operated by either the ordinary Stephenson or Walschaert valve gear, and has no complications outside of the cylinder. Figure 1, Plate III.

An examination of the photographs will show the methods used for attaining the results and refinements mentioned above. It will be seen that the seat and valve are located at an angle of 15 degrees with the transverse horizontal, and that the space between the cylinder and the valve seat is much less than usual, which, taken in conjunction with the very direct steam ports has reduced the amount of clearance, with the same clearance distance between

Plate II.



ALLFREE-HUBBELL CYLINDERS READY FOR APPLICATION TO LOCOMOTIVE.

Fig. 1.

END SECTION OF ALLFREE-HUBBELL CYLINDERS THROUGH THE PORT.

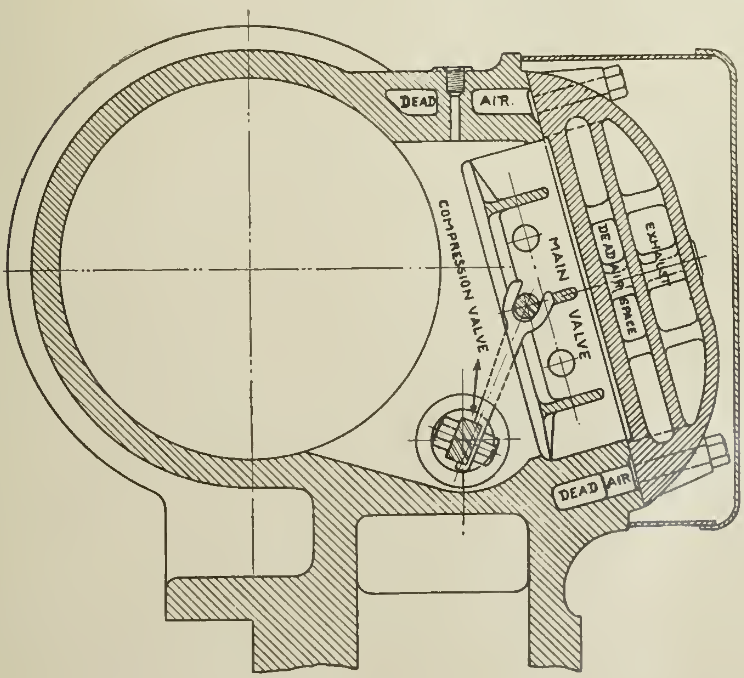


Fig. 2.

PLATE III.

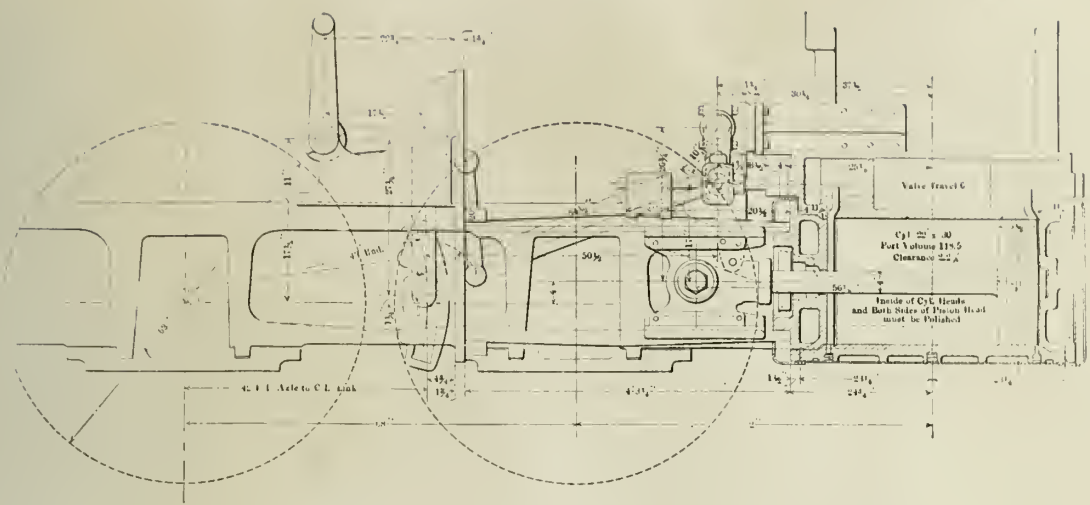
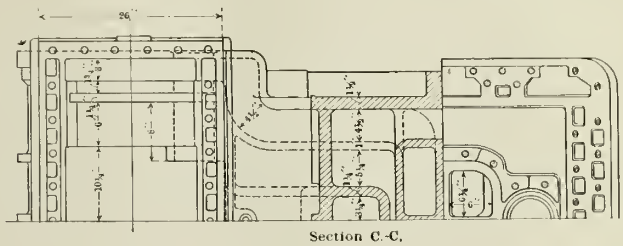
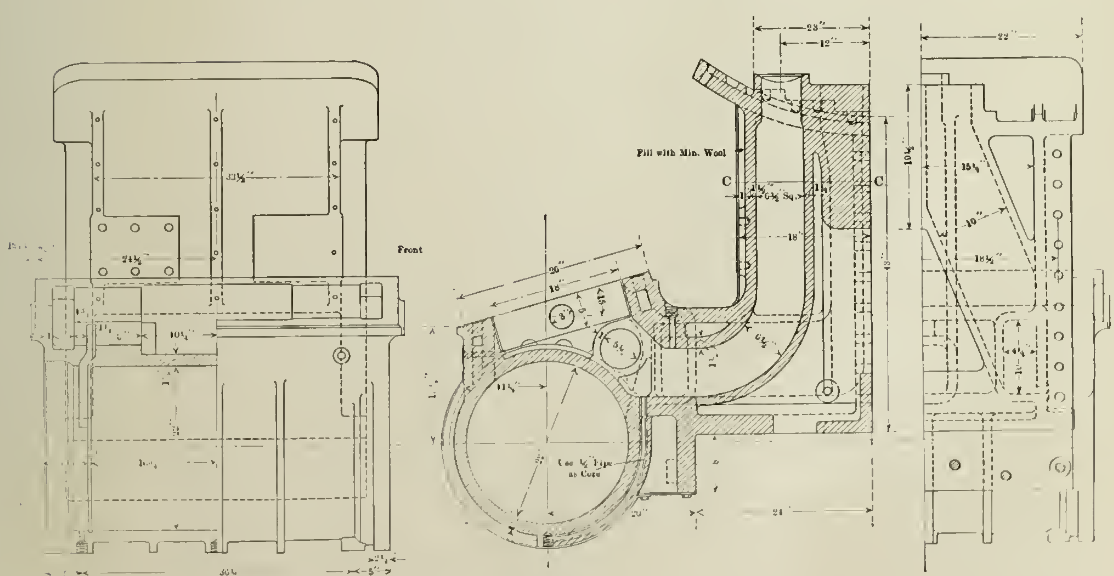


FIG. 1.



Section C.-C.



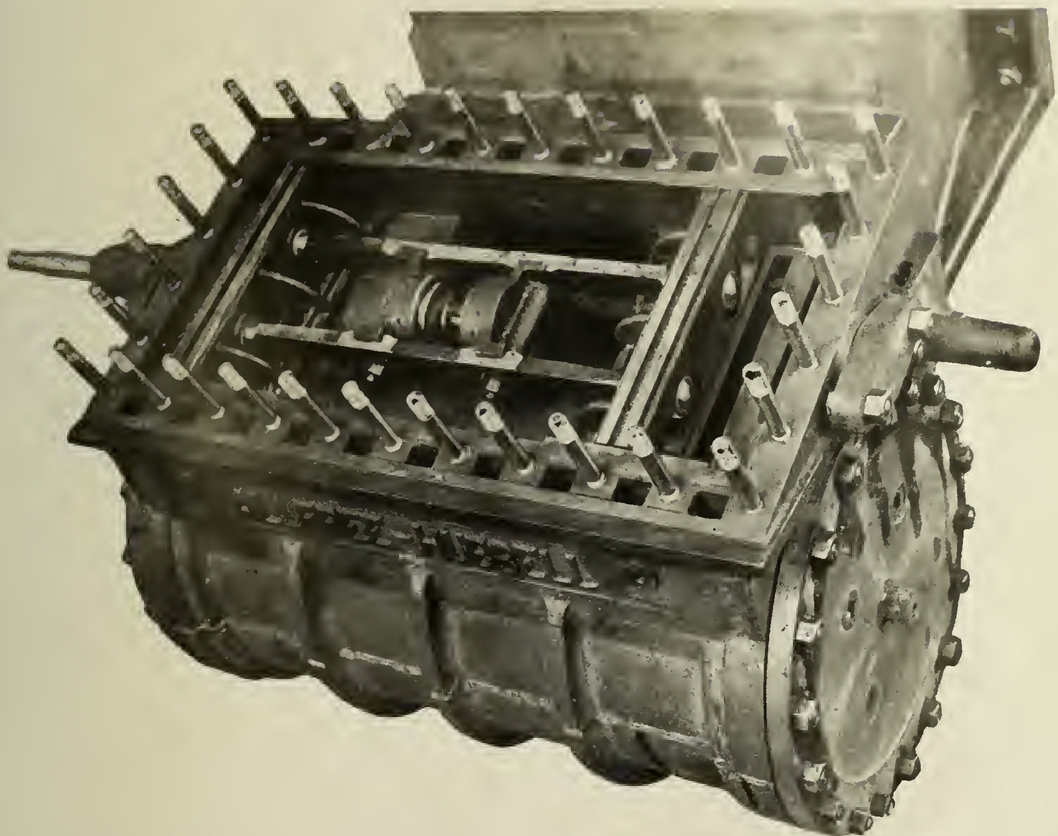
DETAILS OF ALLFREE-HUBBELL CYLINDER.

FIG. 2.

the piston and cylinder head, from 9.55 percent to 3.28 percent as a maximum reduction between the 920 and 940, and from 6.28 to 3.19 percent as a minimum reduction, with an average reduction of 4.58 percent,taking into account both head and crank end clearance. These clearances were actually determined for each engine by filling the clearance space with water, and getting the weight of water required. The volume of the cylinders being known the clearance volume was calculated in percent of this volume. Figure 2, Plate II, and Figure 1, Plate III. See table II of Engine and Boiler Data. In the wall between the cylinder port and the exhaust passage, just below the inner side of the valves, there are openings 5-1/2 inches in diameter which are bushed and fitted with valves. Figure 2, Plate III. These compression controlling valves, as they are called, are simple piston valves with wide rings, and are carried in bushings pressed into place and fastened in the opening. They are guided at either end by an extension of the valve stem fitting into the housings bolted on the outside of the cylinder casting as shown in Figure 1, Plate IV. They are operated by a dash pot connection, at the center of the main steam valves. The dash pot mechanism is so arranged as to give these supplementary valves such a movement as will make them open simultaneously with the exhaust edge of the main valve, but will retard their closing until the main valve has moved about 1-1/4 inches over the exhaust port, thus giving over 23 square inches exhaust opening after the exhaust closure of the main steam valve, and closing it at about 90 percent of the stroke at short cutoffs.

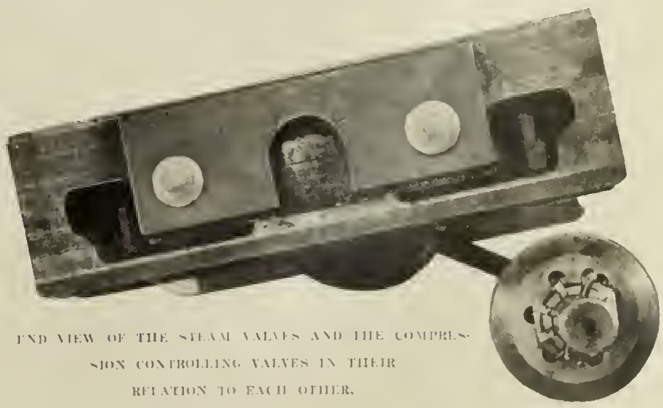
The main steam valves are of a design shown clearly by Figure 1, Plate IV, and have inside admission. It will be seen

PLATE IV.



ALLFREE-HUBBELL CYLINDER SHOWING ONE STEAM CHEST COVER REMOVED, EXPOSING THE STEAM VALVE AND VERY CLEARLY SHOWING THE DASH POT CONNECTION TO THE COMPRESSION CONTROLLING VALVES WHICH LIE IN THE BACK SIDES OF THE PORTS.

FIG. 1.



END VIEW OF THE STEAM VALVES AND THE COMPRESSION CONTROLLING VALVES IN THEIR RELATION TO EACH OTHER.

FIG. 2.

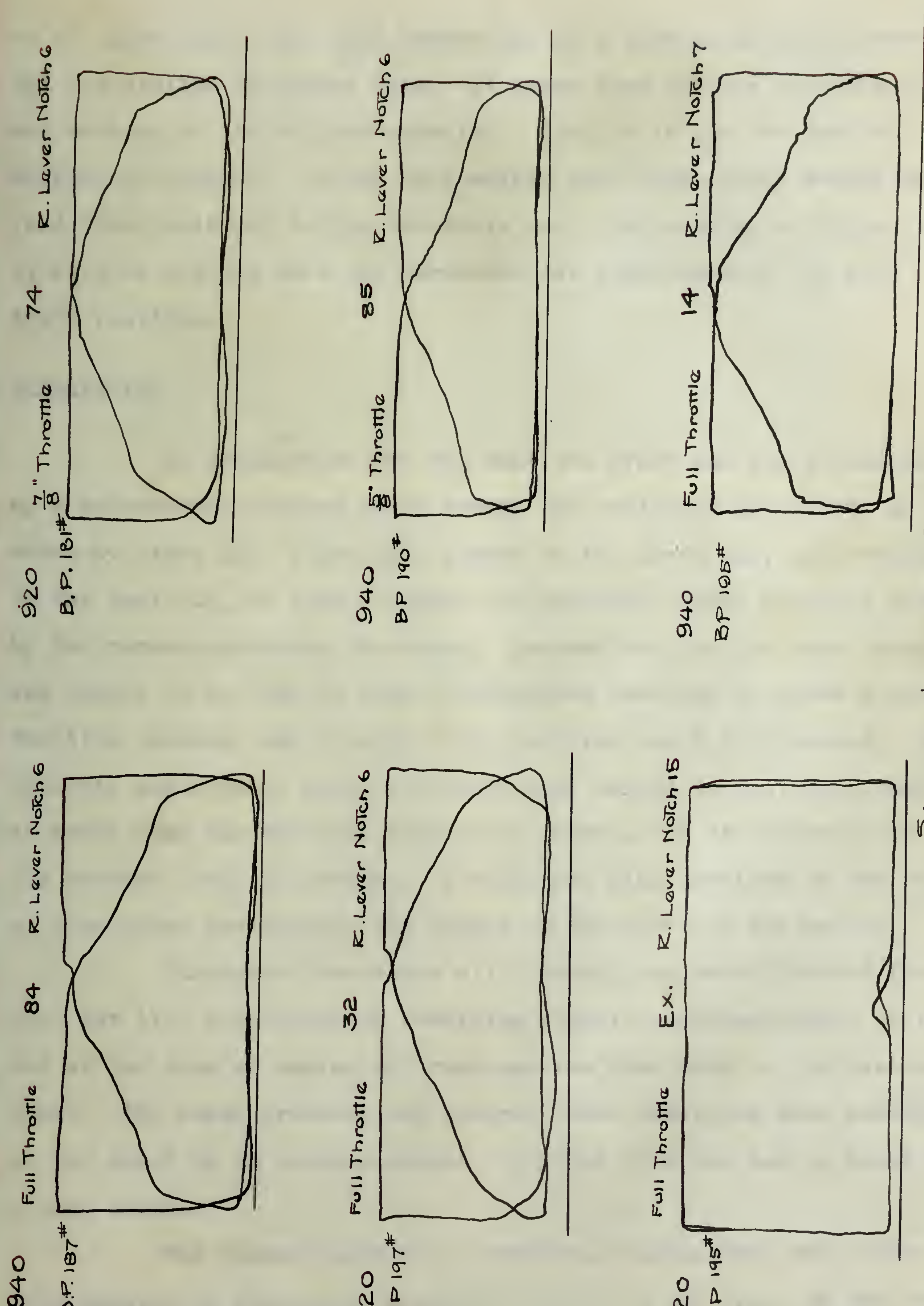
that the construction gives a very light weight valve, with liberal bearing area and perfect balance. The construction is such that even at the shortest cutoff, one portion of the bearing surface of the valve always laps the travel of another portion on the valve seat. Experience with this type of main steam valve, which is the same as was used on the earlier designs, has shown them to be very efficient from a maintenance standpoint.

The steam chest cover which acts as a balance plate for the steam valve is cored out in such a manner as to leave dead air space between the exhaust passage and the lower or live steam surface. Figure 2, Plate II.

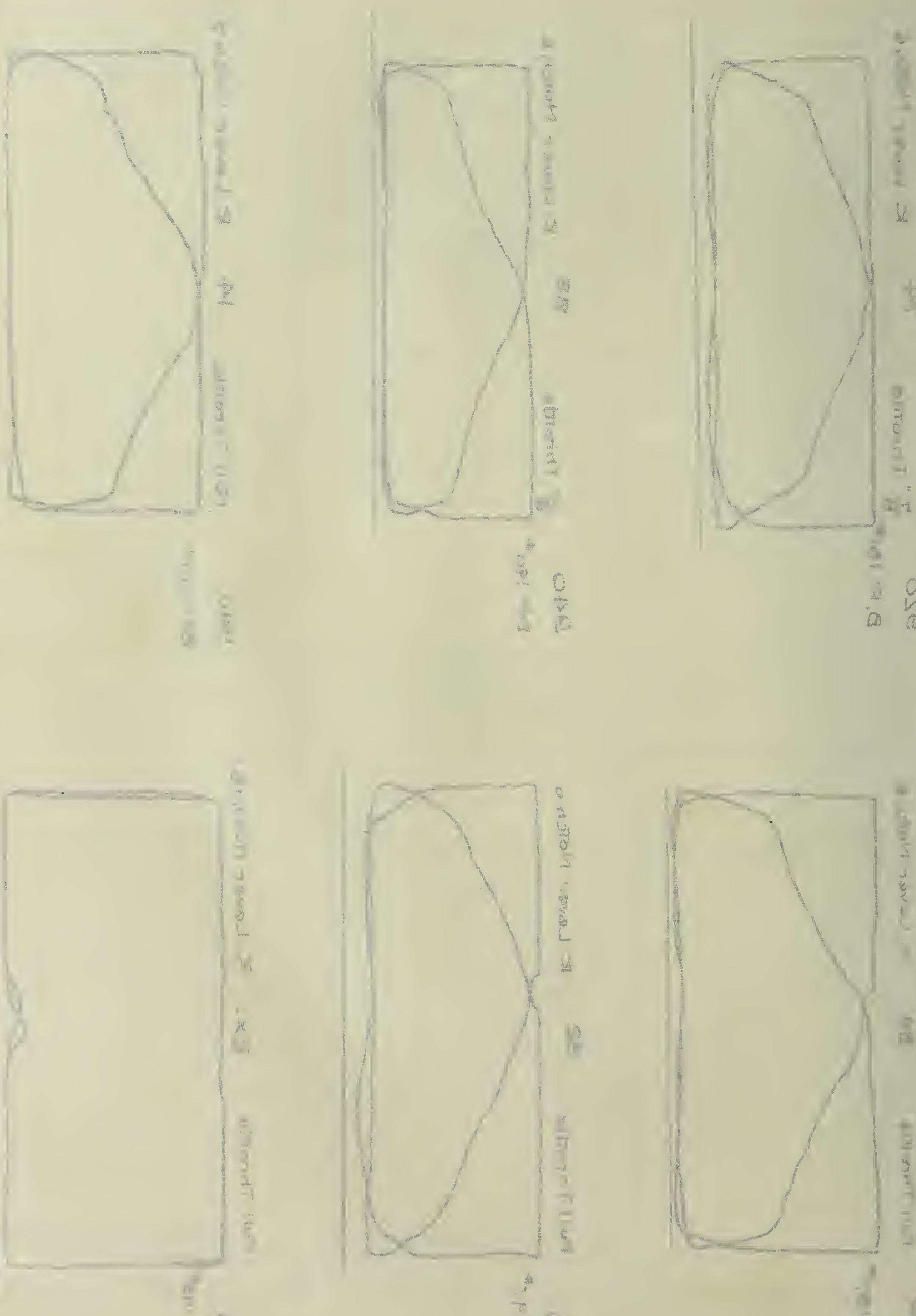
As mentioned above the sides of the pistons, the inside of the cylinder heads and the steam ports are polished. This is a refinement which has not been used in locomotive practice in this country, and is done for the reason that a polished surface is known to absorb much less heat than a rough one.

An examination of indicator cards reproduced on Plate VIII taken on the two engines, working at approximately the same cutoff and throttle positions, shows that by virtue of the larger exhaust opening, the release can be delayed very appreciably without increasing the back pressure, thus giving a longer expansion line. The delay of final exhaust closure, which is permitted by the large reduction of clearance space, allows the back pressure line to be carried very near the end of the stroke and adds considerably to the area of the card.

Three of these cards were selected from among those taken between mile posts 51 and 56 which part of the test is shown graphically on Plate VII. They are cards 84 and 85 of Engine 940, and card



SAMPLE INDICATOR CARDS



74 of engine 920. The card marked Ex. is a card taken just before the 920 stalled on Paxton Hill. It shows very clearly that the 920 was working to its fullest capacity. Card 14 is one for the 940 working in notch 7. It was very seldom that this engine worked beyond this position, during the whole run. By refering to Plate VII, it will be noticed that the cards are for approximately the same train position.

PREPARATION.

In preparation for the test the front end was protected by a substantial housing built around the cylinders and pilot, as shown by Plate IX. A bell was placed on the front end, and connected to the test car, so that a signal for indicator cards could be sent by the person operating the chart. Another bell on the same circuit was placed in the cab so that simultaneous readings of steam pressure throttle opening, and reverse lever position could be obtained. The throttle and reverse lever quadrants were marked so that the observer could read the throttle opening in inches, and the position of the reverse lever in notches. A scale was also provided on the boiler gage glass for reading the height of the water in the boiler.

Throughout the tests all observations were directed from Test Car 17, all observers receiving signals simultaneously. A record of the time of taking all readings was also made on the test car chart. The steam pressure and reverse lever positions were recorded on the chart by an electro-magnet, operated from the cab by means of a push button.

The tender tanks were previously calibrated, and scales were painted on diagonally opposite corners of the tank, so that the

PLATE IX.

PLATE IX A.

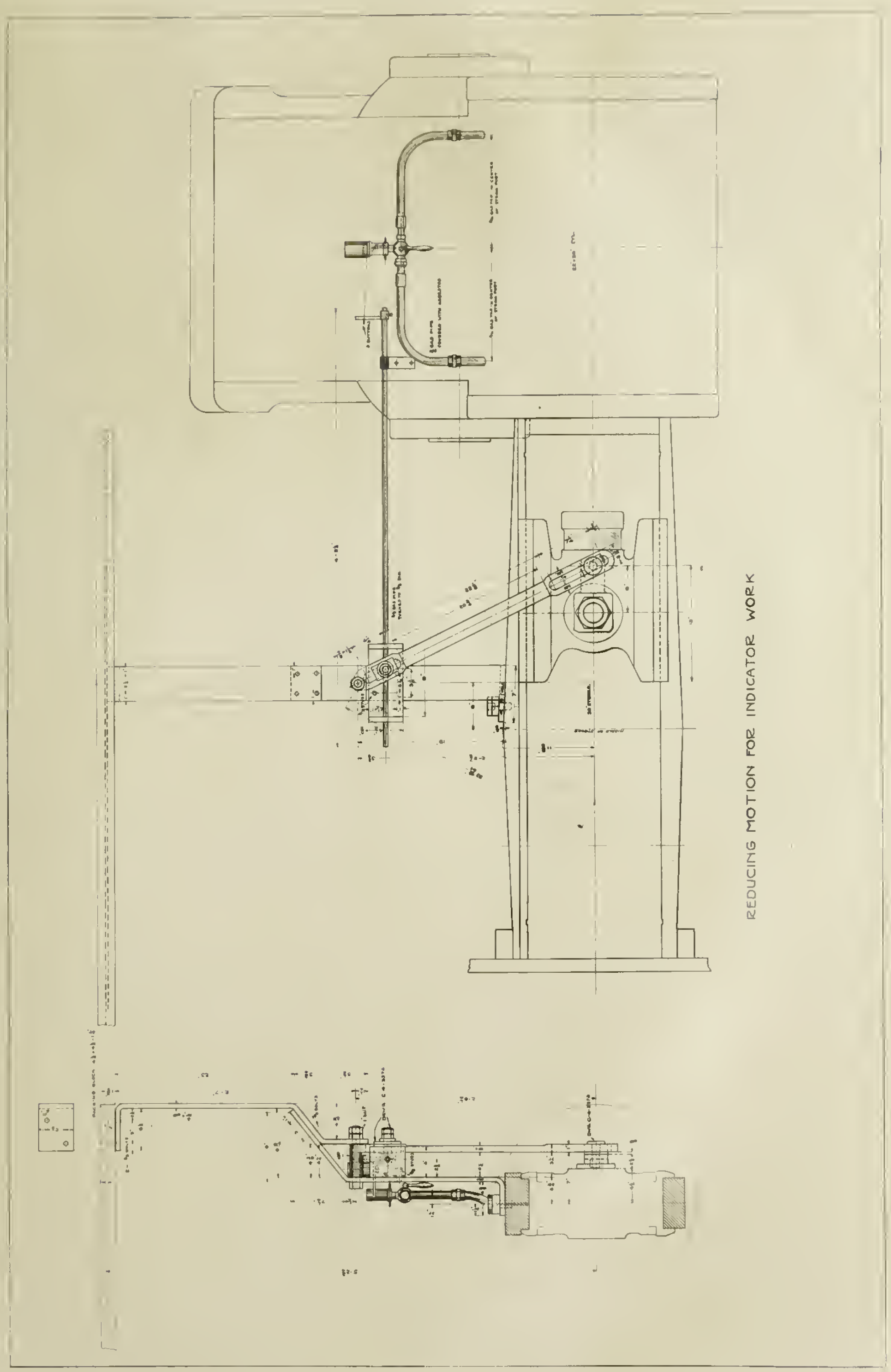
average height could be obtained. The height of the water was obtained by means of a hose, connected to the bottom of the tank, with a glass tube inserted in the free end. Readings were obtained by lowering the hose until water was visible in the glass tube. Then by placing the tube alongside of the scale on the tender, the height could be easily read.

The water cosumed during each test was determined by noting the height of water in the tender at the beginning and end of each run, and before and after taking water. By the calibration, the weight corresponding to a given height in the gage glasses was known.

The reducing motion as shown by Plate V, needs no explanation. Crosby indicators were attached to each cylinder as shown on the Plate. 3/4 inch pipes, as short as possible, and having easy bends were used. The pipes were wrapped with heavy cord, and an additional covering of waste was put around them during the tests. Revolution counters were placed on both sides and were actuated by a wire attached to the reducing motions. Readings of the R.P.M. were taken over half minute intervals, beginning about 15 seconds before the actual taking of the cards. The indicator springs were calibrated and found to be practically correct.

Seven observers were stationed on the locomotive, as follows: on the front end there were five men, two to take cards, two to read the revolution counters and record the cards. The fifth man was necessary to blow a whistle when the bell rang as the card takers were unable to hear the signals when the engines were working hard. Two men were placed in the cab whose duties were to take the readings previously referred to.

PLATE V.



REDUCING MOTION FOR INDICATOR WORK

It would have been desirable to have retained the same engine crew throughout the series of daily tests, but for company reasons this plan had to be abandoned. Instructions were issued to each crew, at the start of the tests, to make the best time possible. The make up of the trains was as nearly alike in tonnage, number of cars and kind of cars as possible under the traffic conditions existing at the Champaign yards, on the different days. See Table of Summarized Results.

On the chart in the test car the following records were obtained by means of curves and offsets, the draw-bar pull, speed in miles per hour, wind direction and velocity, time in five second intervals, position of indicator cards, air brake applications, reverse lever position, steam pressure and mile posts. The chart travels at the rate of 13.2 inches per mile of car travel or 400 feet to the inch.

As all readings were taken they were entered on suitable log sheets and time of taking recorded.

COMPUTATIONSOF RESULTS.

DRAW-BAR HORSEPOWER.

The draw-bar horse power, at the points where indicator cards were taken, on Paxton Hill and the grade just out of Kankakee, was calculated by obtaining the draw-bar pull in pounds from the draw-bar pull curve on the dynamometer record. The horse power was then calculated by the following formula:-

$$\text{Db.H.P.} = \frac{\text{Db.P. x Speed (Ft. per Min.)}}{33000}$$

The speed in feet per minute was obtained from the revolution counters on the front of the engine.

AVERAGE DRAW-BAR HORSE POWER.

In calculating the average draw-bar horse power, the average draw-bar pull was first obtained by planimetering the draw-bar pull curve, and dividing the area thus obtained by the length of the chart under it. The running time was then taken directly from the dynamometer record, and from this, the distance being known, the average running speed was determined. The product of these two and the proper constant then gave the average draw-bar horse power.

STEAM CONSUMPTION FROM TANK MEASUREMENT.

In determining the water used per draw-bar horse power per hour, the water used per hour was first determined by dividing the total water used by the running time in hours between the initial and final water readings. This quantity divided by the average draw-bar horse power gave the water used per draw-bar horse power per hour. When making the tests it was not possible to make the initial and final water readings correspond exactly with the beginning and end of the test, the running time between these readings being from five to fifteen minutes greater than the running time during the test. It was therefore necessary to make an assumption as to the power developed during this short period of time. It was assumed that this power was the same as the average power during the rest of the test.

STEAM CONSUMPTION FROM INDICATOR CARDS.

The purpose of calculating the steam consumption from the indicator cards was simply to get the comparative values for the 920 and 940 under like conditions of cut -off, steam pressure, etc. For this purpose, cards were selected from each test at three different cut-offs, the corresponding cards in the different tests having approximately the same cut-offs, and initial steam pressures. The results obtained in this manner are given below.

APPROXIMATE CUT-OFF	STEAM USED PER INDICATED HORSE POWER PER HOUR	
% OF STROKE	ENGINE 940 Test S1013	ENGINE 920 Test S1017
37	21.4	24.9
49	22.0	24.4
68	19.0	26.1

RESULTS.

On pages 38,39,40, will be found a table of summarized data and results. The runs are comparable both as regards power developed and water consumed.

The power developed by engine 920 is taken as the basis of comparison. Engine 940 developed 16.5 percent more draw-bar horse power then Engine 920, and at the same time consumed 15.1 percent less water per draw-bar horsepower. Three weeks after the completion of the tests the cylinders of Engine 920 were opened for the purpose of determining diameters and clearances, when it was discovered that both piston rings on the left side were broken. It is

not probable that the rings were broken during the test, as they were new a few days before, and the engineer would have noticed a leakage of any size.

GRAPHICAL RESULTS.

Plate X, Pages 27 - 37 , shows the draw-bar pull and speed curves of the two locomotives for the entire run. These curves were reproduced directly from the charts obtained in the dynamometer car, and will serve to show the general performance of the engines. Below these curves the profile of the road between mile-posts 128 and 18 is given. This profile was taken directly from the one furnished the University by the Railroad Company. The figures above the profile indicate the grade in feet per mile, those below the height above sea level.

In order that a more careful comparison of the two engines may be made, more detailed curves are plotted on Plates VI, and VII, showing the performances of the two locomotives on two heavy grades. Plate VI is for the Paxton grade, and Plate VII for the grade just north of Kankakee. As will be seen the position of the reverse lever, throttle opening, speed in miles per hour, draw-bar pull, boiler pressure, indicated horse power and draw-bar horse power are plotted for the two engines. Thus at any point one is enabled to see how either engine is working. The data plotted for the 920 is the second trial to get over the hill with its train, after one unsuccessful attempt. It will be noted that the steam pressure of the 920 was lower than that of the 940, also that the 920 was worked with a longer cut-off, full throttle opening being used on both engines.

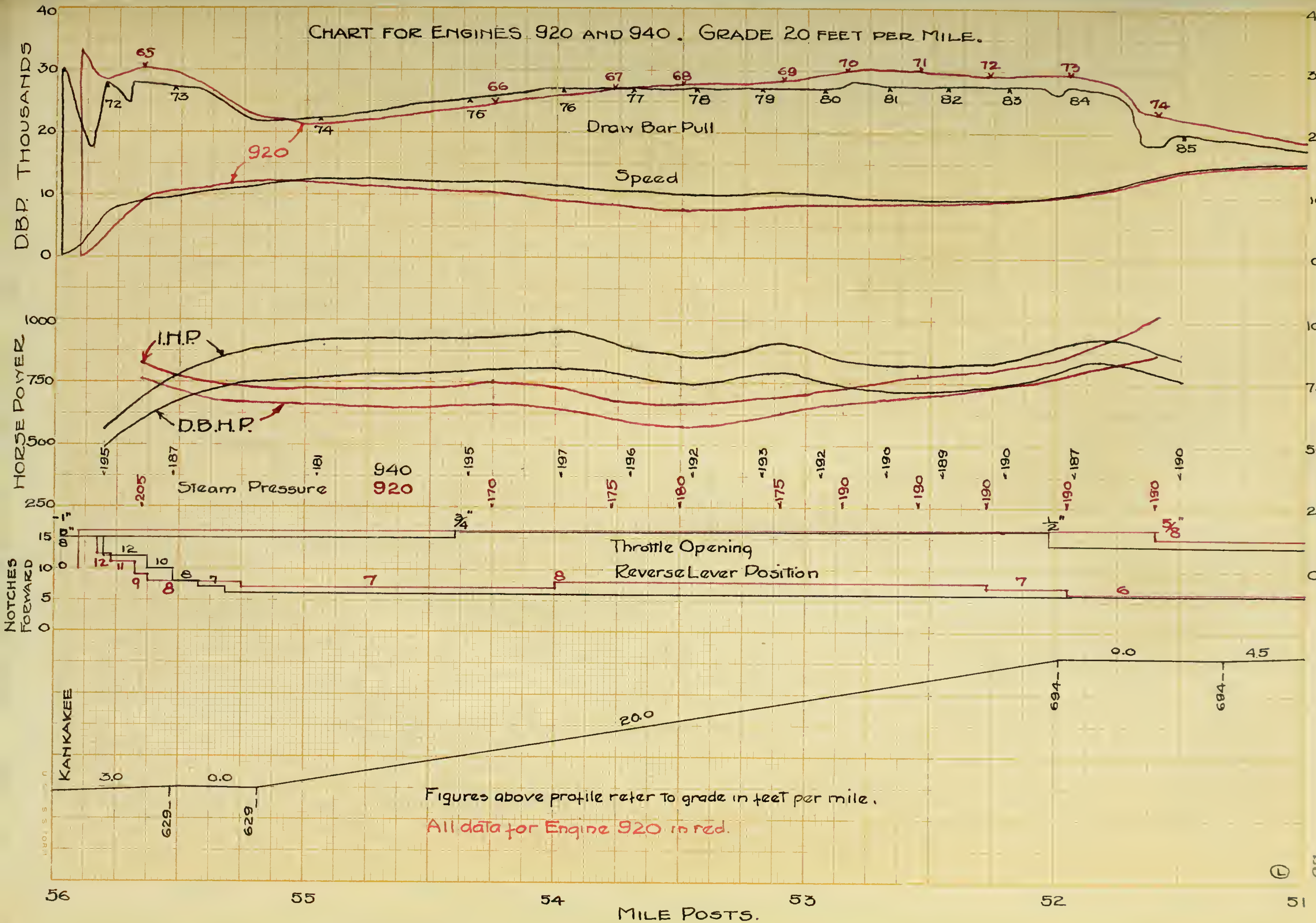


CHART FOR ENGINES 920 AND 940. GRADE 20 FEET PER MILE.
D.B.P. THOUSANDS
SPEED M.P.H
Draw Bar Pull
Speed
920
HORSE POWER
I.H.P.
D.B.H.P.
Steam Pressure
940
920
Throttle Opening
Reverse Lever Position
NOTCHES FORWARD
KANKAKEE
Figures above profile refer to grade in feet per mile.
All data for Engine 920 in red.
MILE POSTS.

PLATE VII.

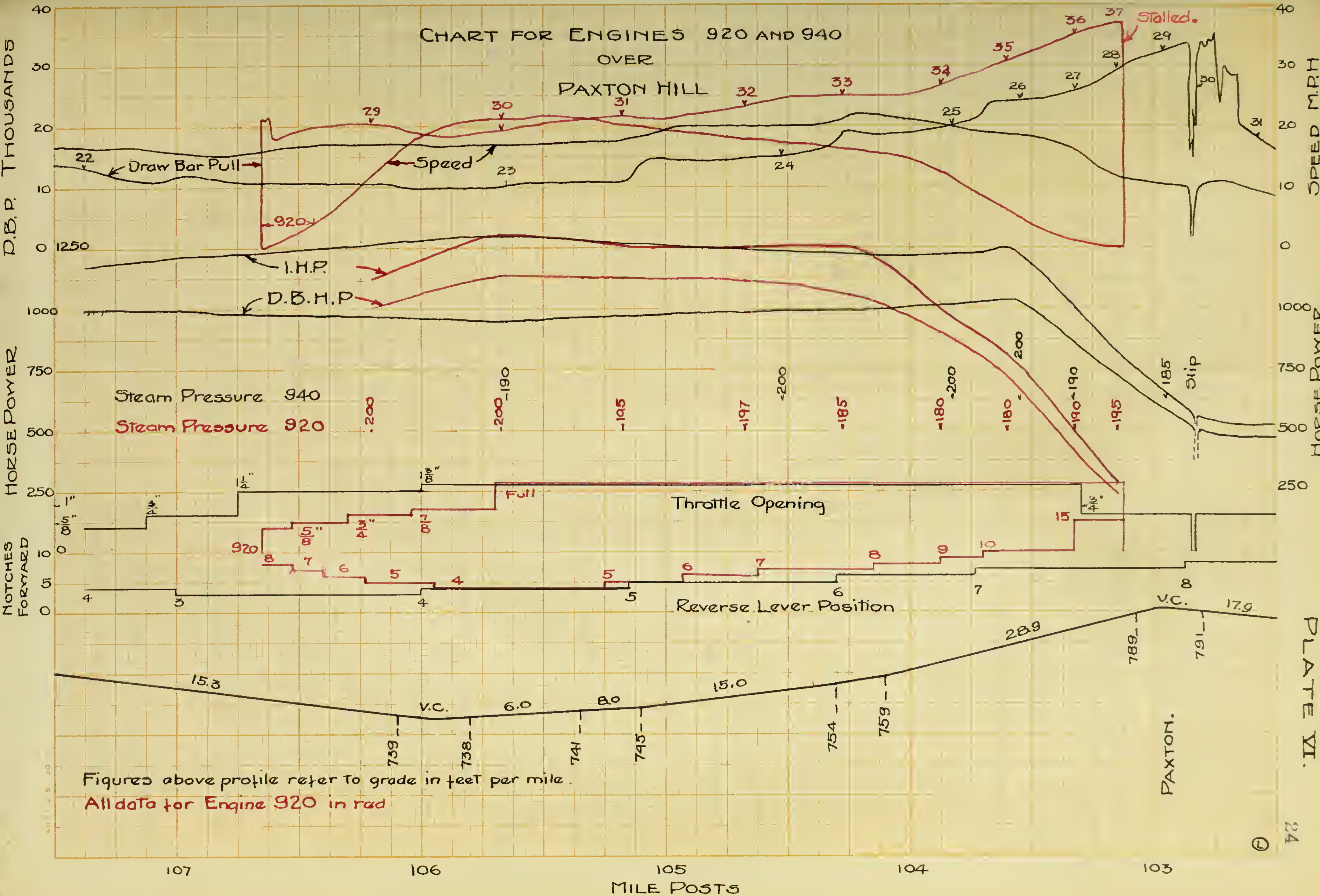


Chart for Engines 920 and 940
over
Paxton Hill
Stalled.
Draw Bar Pull
Speed
I.H.P.
D.B.H.P.
Slip
Steam Pressure 940
Steam Pressure 920
Throttle Opening
Full
Reverse Lever Position
D.B.P. Thousands
Speed M.P.H.
Horse Power
Notches Forward
Mile Posts
V.C.
Paxton.
Figures above profile refer to grade in feet per mile.
All data for Engine 920 in red

Plate VI.

CONCLUSION.

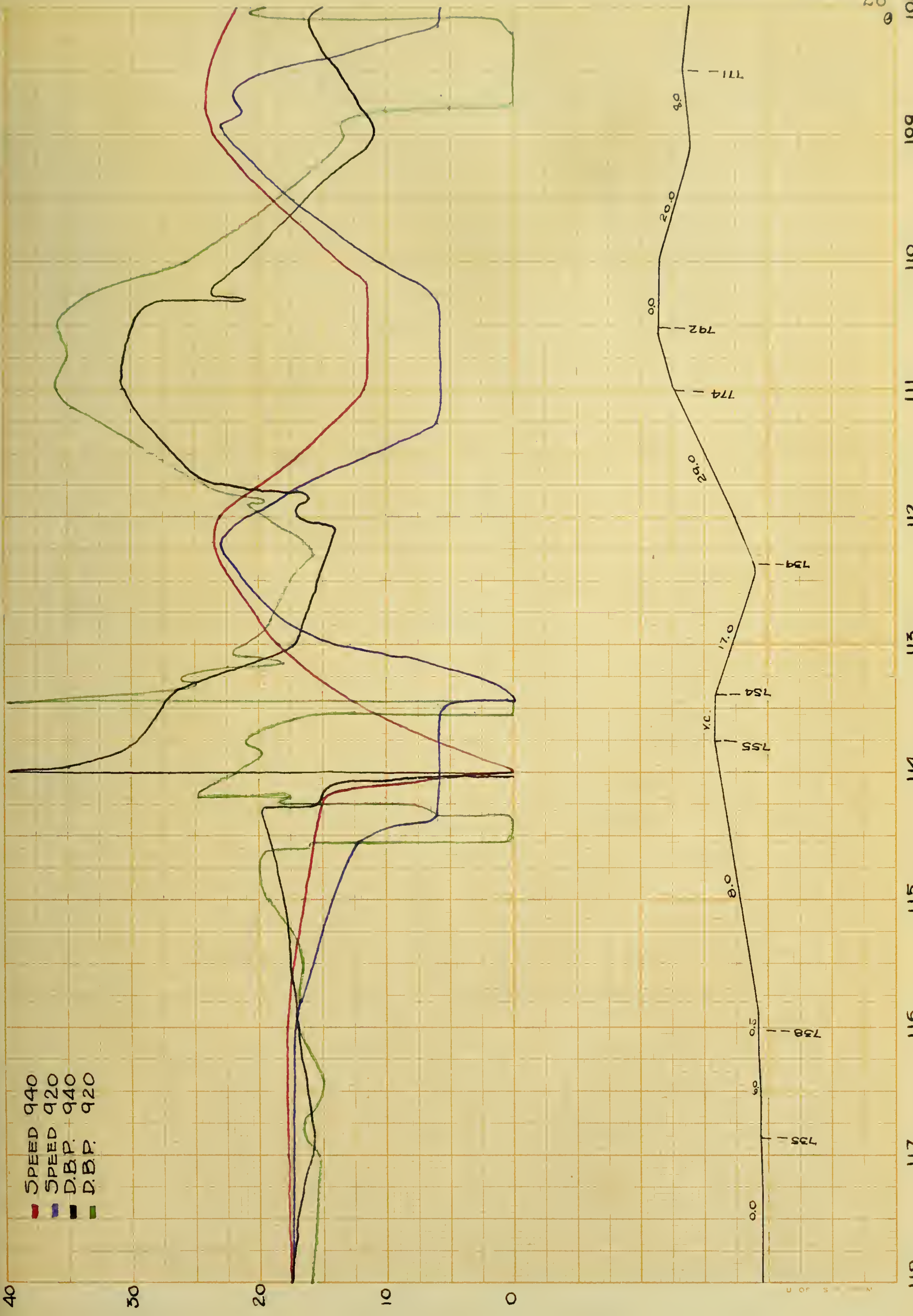
From the data presented it is interesting to note that the 940 consistently gave a better performance than the 920, under practically the same conditions, and with marked economy. At nearly all times during the test there was a "pound" in the right-hand cylinder of Engine 940. As was pointed out in the discussion of the Allfree-Hubbell valve, the gain in economy is made possible by a reduction in clearance space and compression. When the engine was acting normally, with the right-hand valves set as they were, the "pound" was very marked at low speeds. At other times there was an irregular exhaust, and absence of the "pound". Cards taken at these times show a higher compression on the head end. This indicates a quicker exhaust closure and shows that the compression controlling valve on the right-hand side normally allowed too low a compression, which was probably due to the sticking of the compression controlling valve, thus delaying final exhaust closure too long, resulting in insufficient compression. However, the severity of the "pound" might be partly attributed to loose rods, crosshead quides, or a loose driving box. The above conditions show that it is more difficult to prevent a "pound" with this type of cylinder and valve, on account of the low compression with which they work. In connection with the increase in efficiency of the 940, it is only proper to point out that an indeterminate portion of the difference in economy might have been produced by the difference in efficiency of the engine crews.

From the fact that Engine 940 gave a better performance than Engine 920, allowing for the difference in engine crews, it is n.

probable that the 940, as equipped, is the better engine of the two.

PLATE X A


SPEED 940
SPEED 920
D.B.P. 940
D.B.P. 920
DRAW BAR PULL IN THOUSANDS OF POUNDS.
SPEED IN MILES PER HOUR.
MILE POSTS
40
30
20
10
0
128
127
126
125
124
123
122
121
120
119
118
10.
7.9
10.3
14.2
0.0
3.0
0.0
6.2
0.0
VC
0.0
732
729
736
735
733
731
730
730
727
731
732
U. OF I. S. S. FORM


SPEED 940
SPEED 920
D.B.P. 940
D.B.P. 920
40
30
20
10
0
108
109
110
111
112
113
114
115
116
117
118

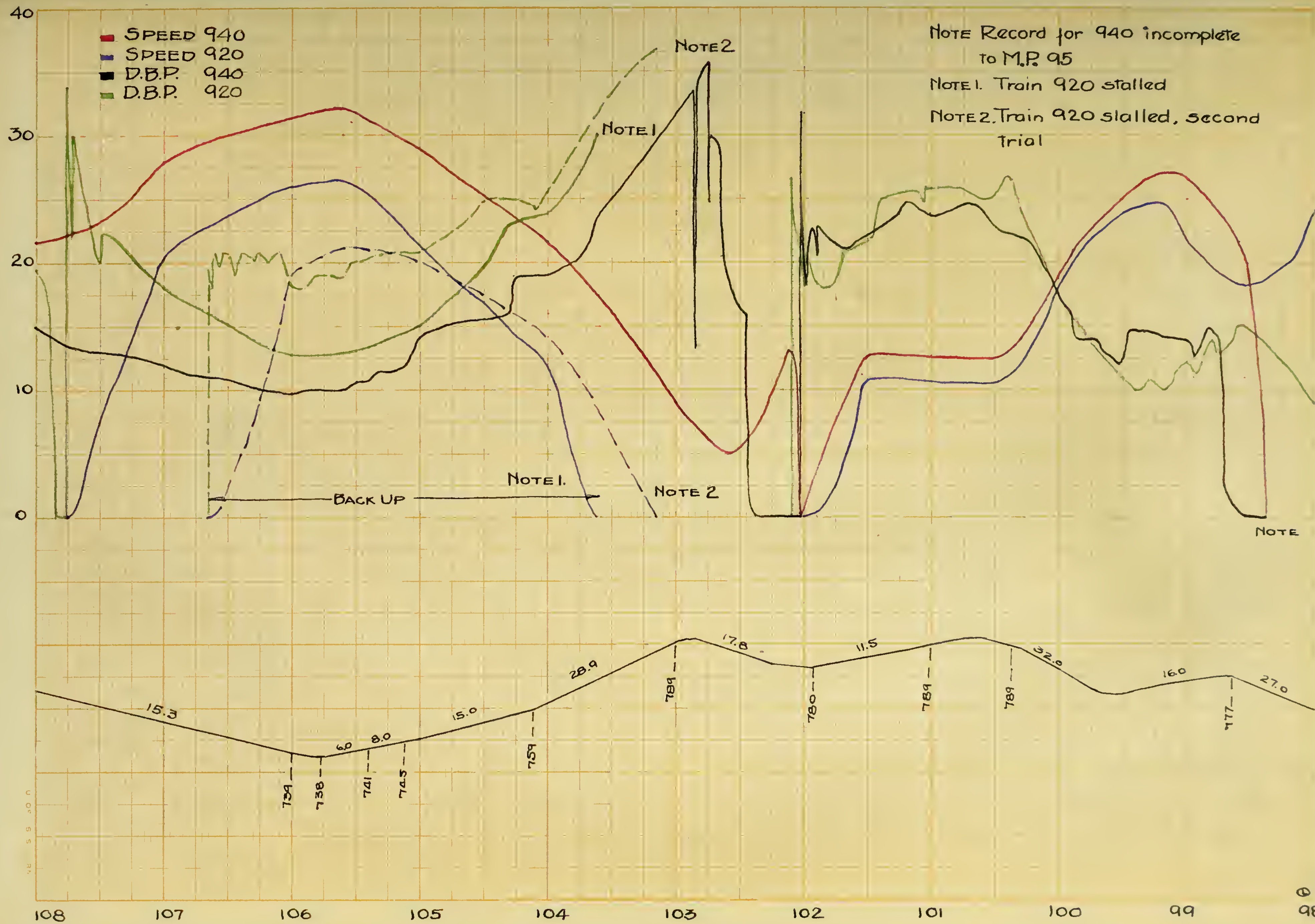
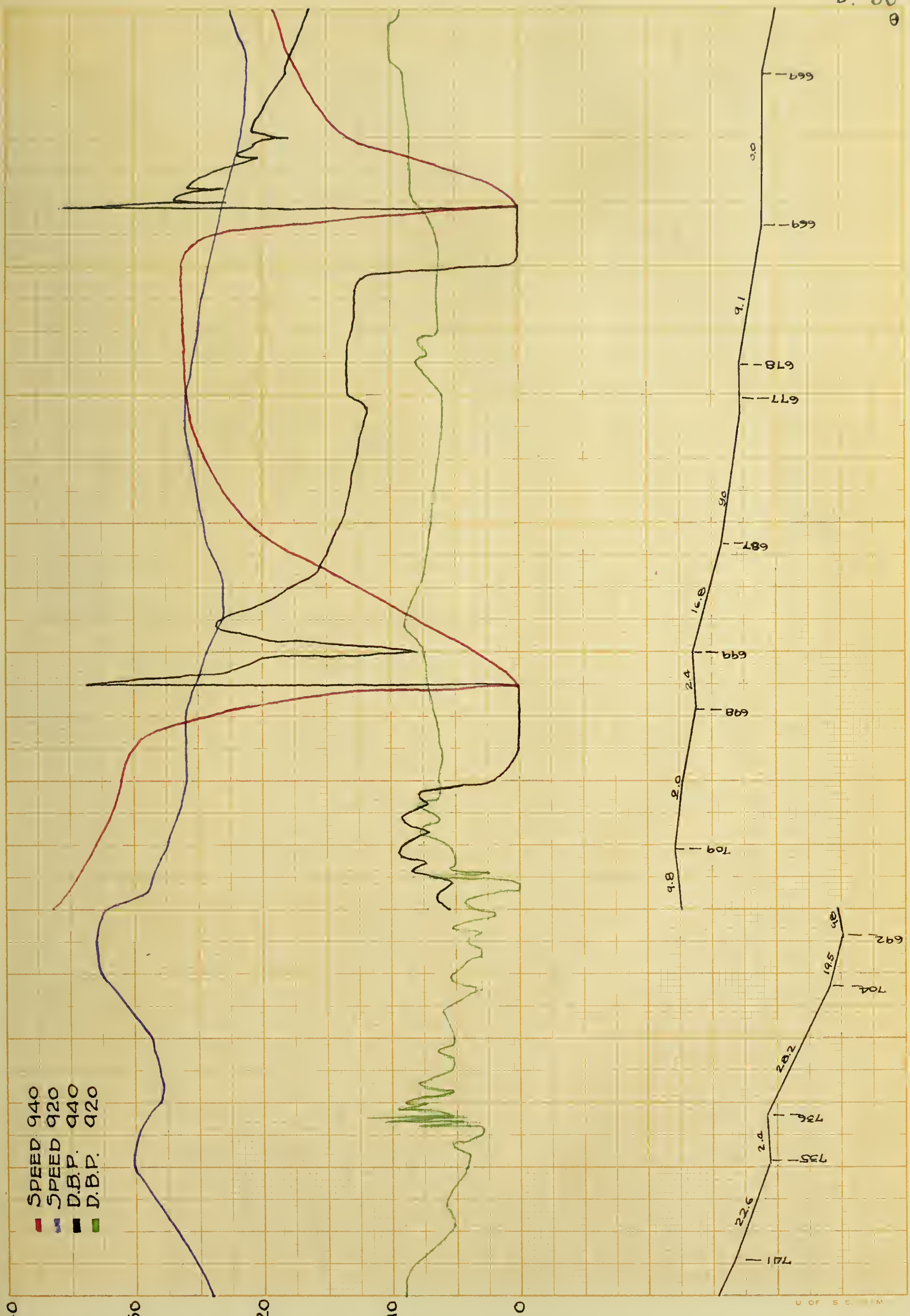

SPEED 940
SPEED 920
D.B.P. 940
D.B.P. 920
NOTE Record for 940 incomplete to M.P. 95
NOTE 1. Train 920 stalled
NOTE 2. Train 920 stalled, second trial
NOTE 2
NOTE 1
NOTE 1.
NOTE 2
BACK UP
NOTE
40
30
20
10
0
15.3
6.0
8.0
15.0
28.9
17.8
11.5
32.0
16.0
27.0
739
738
741
745
759
789
780
789
789
777
108
107
106
105
104
103
102
101
100
99
98

PLATE X. p. 30



SPEED 940
SPEED 920
D.B.P. 940
D.B.P. 920
40
30
20
10
0
88
89
90
91
92
93
94
95
96
97
98
669
669
678
677
687
664
668
706
692
704
736
735
721
9.0
9.1
9.0
16.8
2.4
2.0
9.8
9.8
19.5
28.2
2.4
22.6

PLATE X.

E. 31

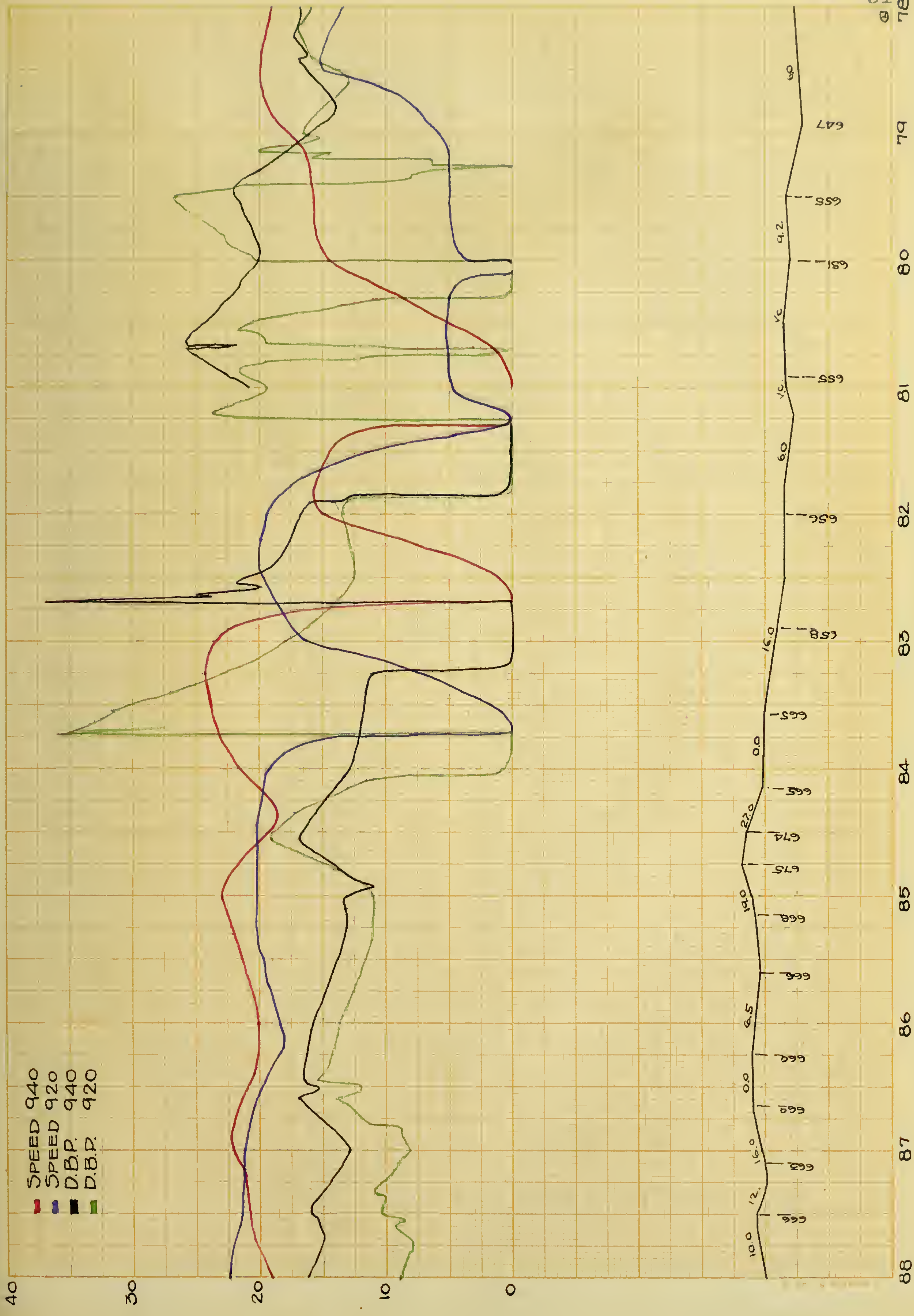

SPEED 940
SPEED 920
D.B.P. 940
D.B.P. 920
40
30
20
10
0
78
79
80
81
82
83
84
85
86
87
88

PLATE X.

F. 32

SPEED 940
SPEED 920
D.B.P. 940
D.B.P. 920
40
30
20
10
0
68
69
70
71
72
73
74
75
76
77
78

PLATE X.

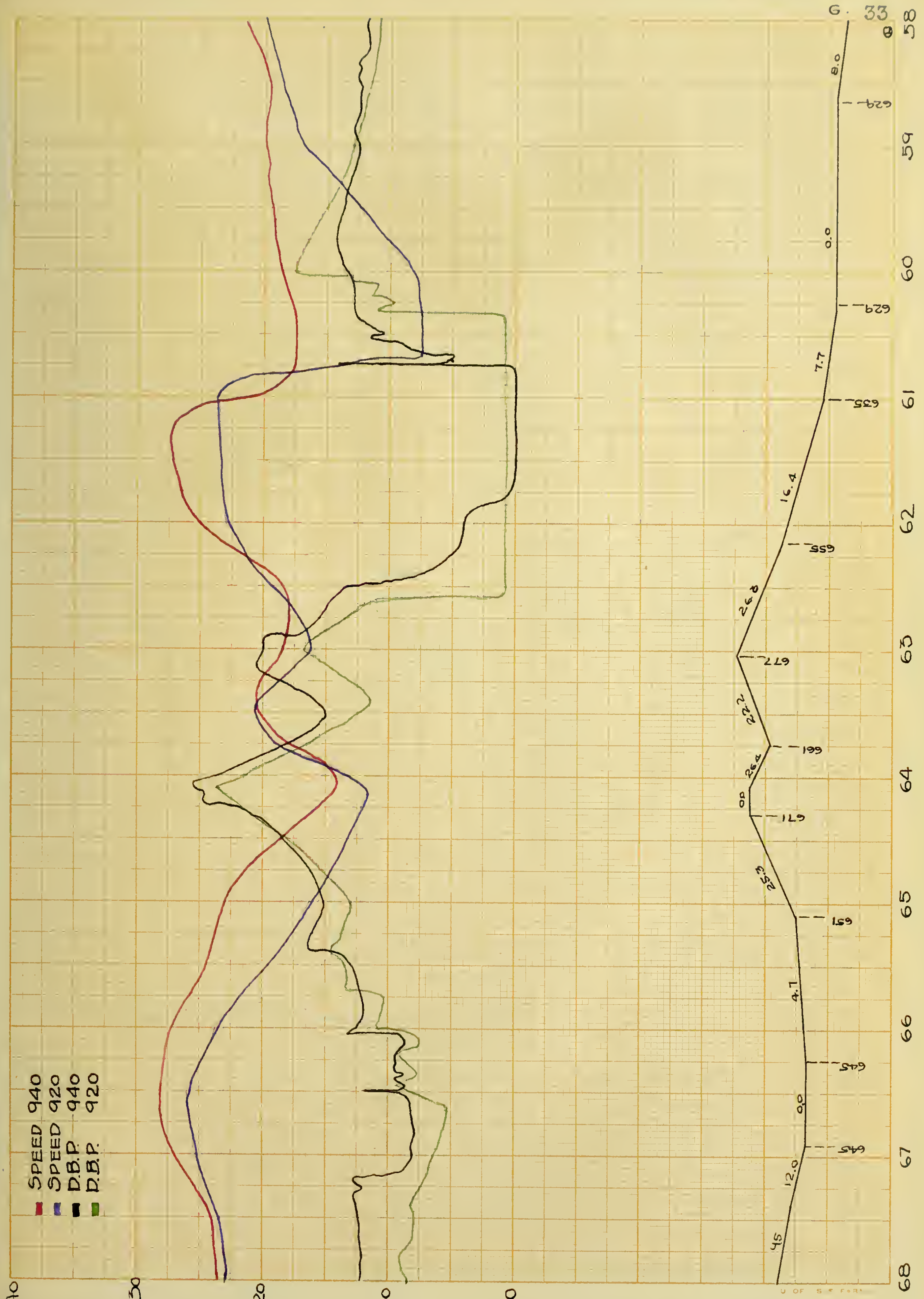
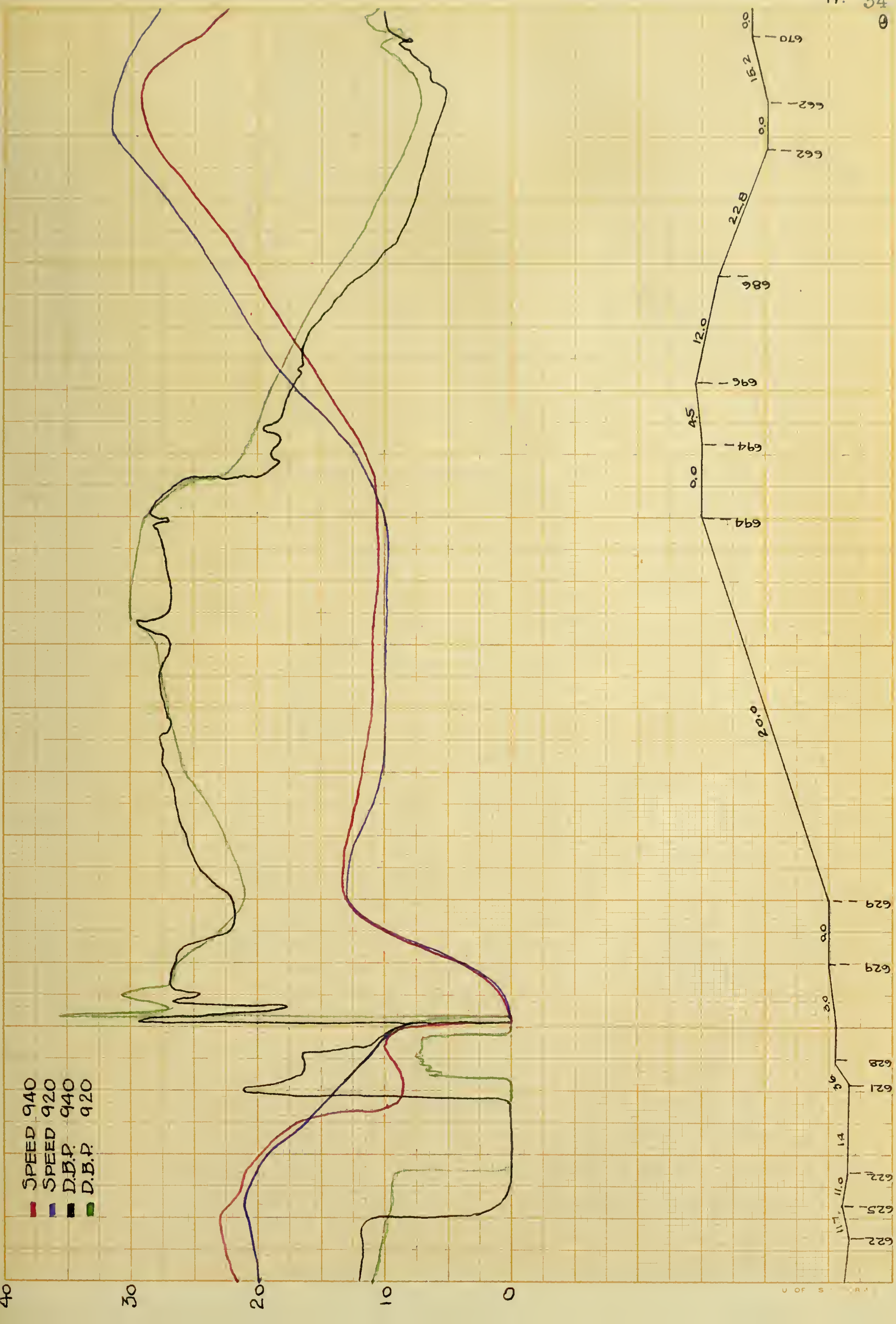

G. 33
SPEED 940
SPEED 920
D.B.P. 940
D.B.P. 920
40
30
20
10
0
58
59
60
61
62
63
64
65
66
67
68
8.0
629
0.0
629
7.7
635
16.4
655
26.8
677
22.2
661
26.4
0.0
671
25.3
651
4.1
645
0.0
645
12.0
45

PLATE X.

H. 34



SPEED 940
SPEED 920
D.B.P. 940
D.B.P. 920
0
10
20
30
40
48
49
50
51
52
53
54
55
56
57
58
15.2
0.0
22.8
686
12.0
696
4.5
694
0.0
694
20.0
629
9.0
629
3.0
628
621
1.4
622
11.0
625
11.7
622

PLATE X.

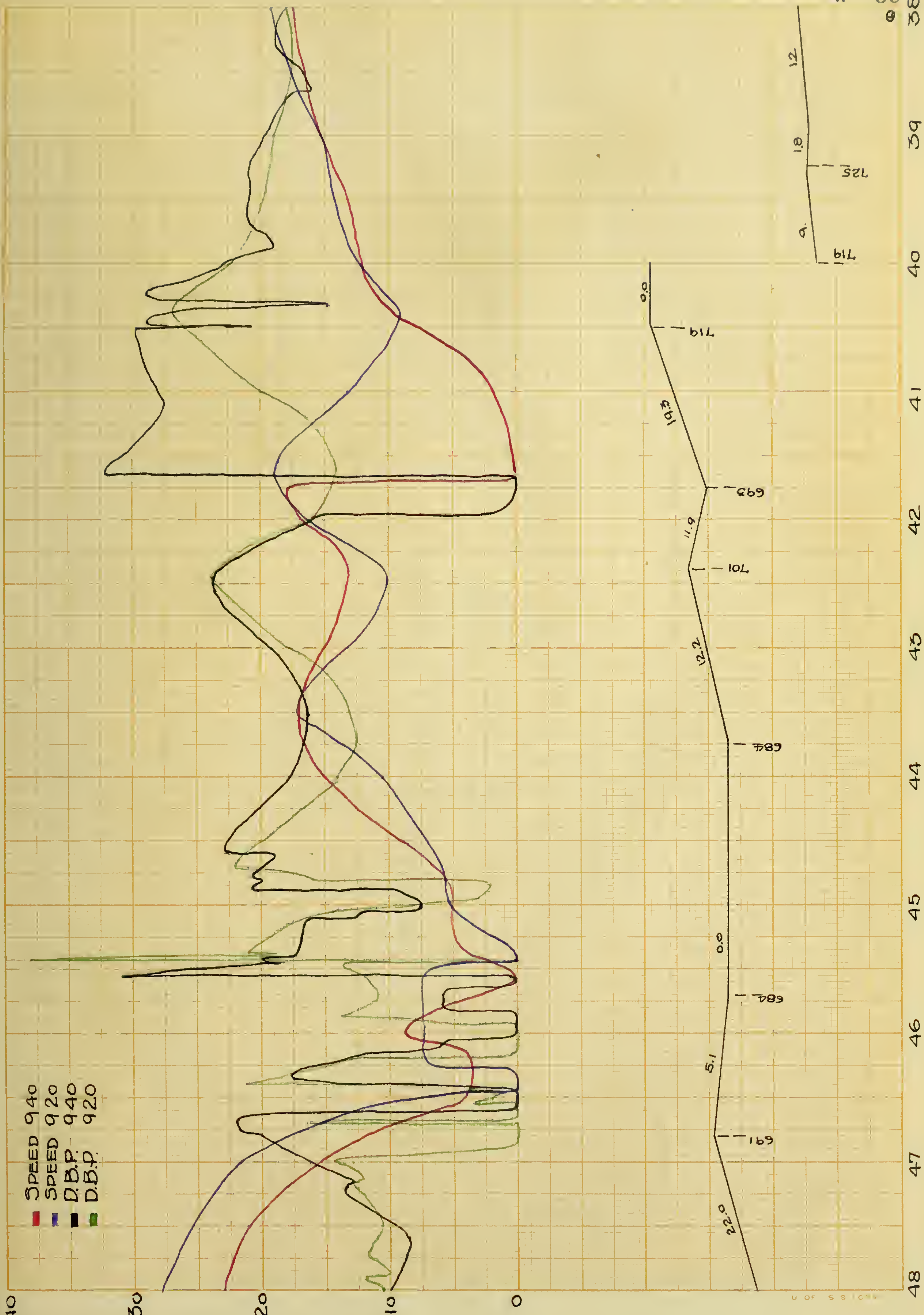
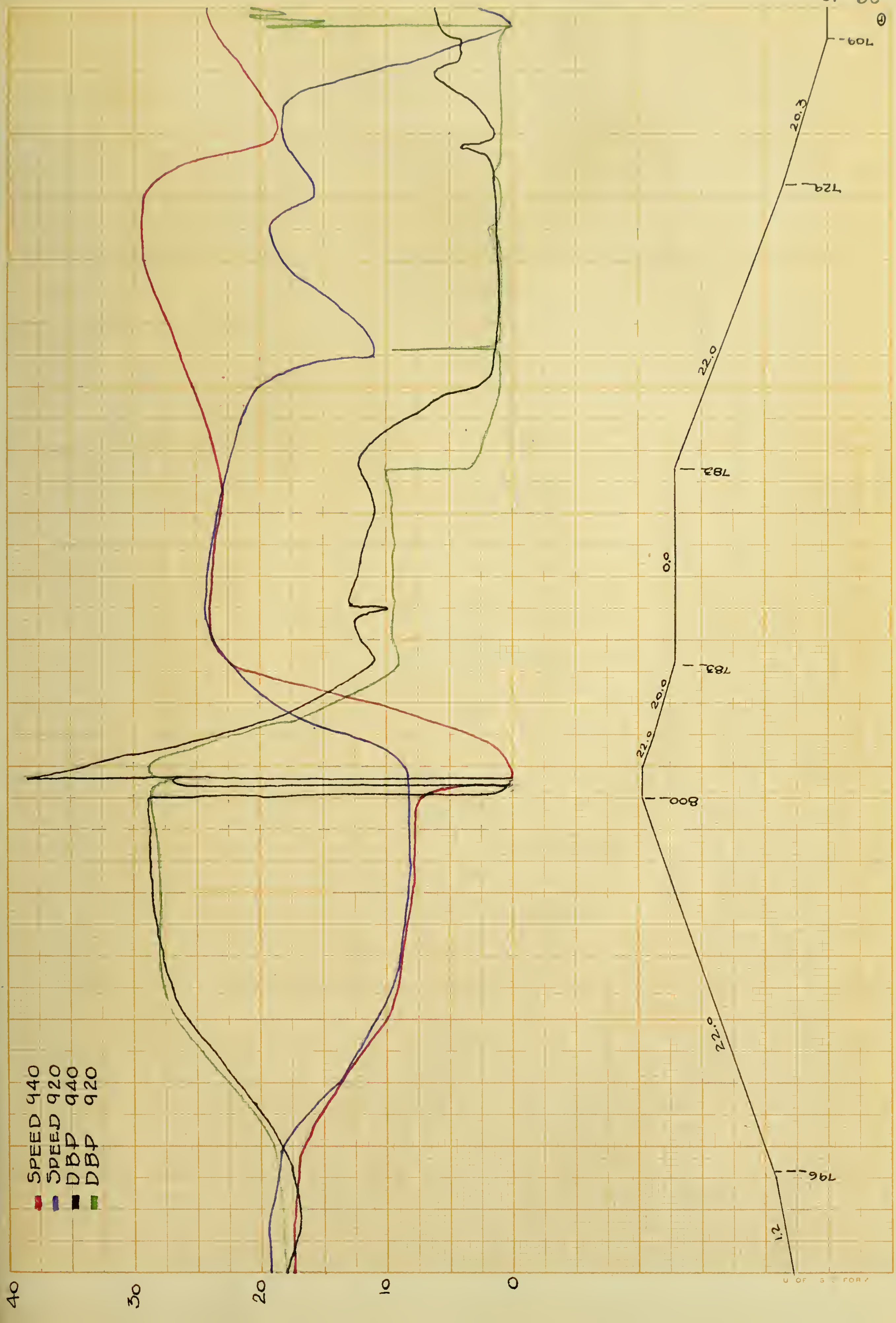

SPEED 940
SPEED 920
D.B.P. 940
D.B.P. 920
38
39
40
41
42
43
44
45
46
47
48
0
10
20
30
40
1.2
1.8
725
9.
719
0.0
719
19.3
693
11.9
701
12.2
684
0.0
684
5.1
691
22.0

PLATE X.

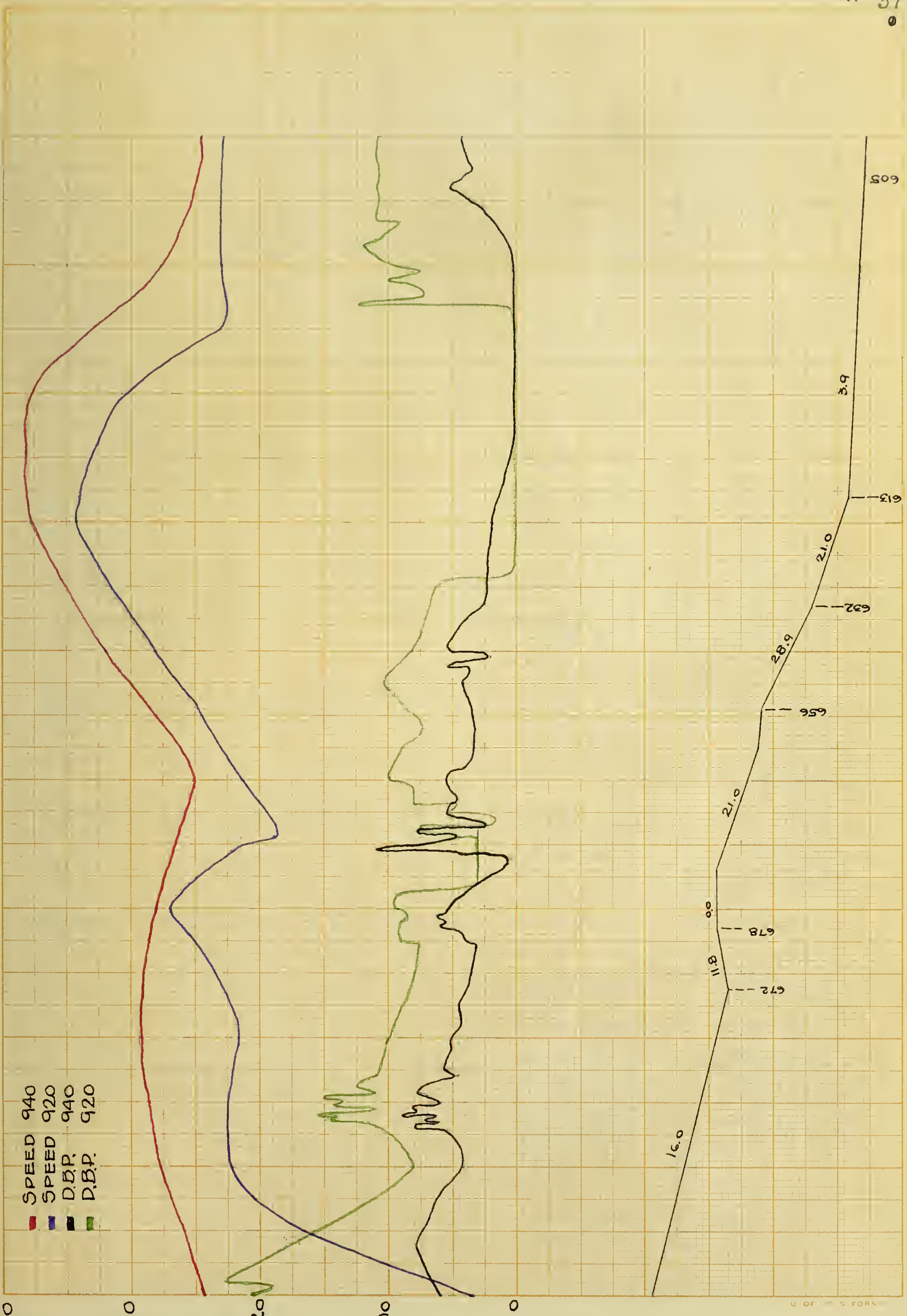
J. 36



SPEED 940
SPEED 920
DBP 940
DBP 920
28
29
30
31
32
33
34
35
36
37
38
40
30
20
10
0
709
724
783
783
800
796
20.3
22.0
0.0
20.0
22.0
22.0
1.2

PLATE X.

K. 37



SPEED 940
SPEED 920
D.B.P. 940
D.B.P. 920
18
19
20
21
22
23
24
25
26
27
28
40
30
20
10
0
605
3.9
613
21.0
632
28.9
656
21.0
0.0
678
11.8
672
16.0

Summarized Data & Results

Tests of Illinois Central Locomotives 920, & 940.

MADE APRIL 27 - MAY 2 1908.

Test Number	S1013	S1017
Engine Number	940	920
Train No.	Ex 940 N.	Ex. 920 N.
Date of Test	4-27-08	5-1-08
From	Champaign	Champaign
To	Chicago	Chicago
Engineer	Ulirich	Allen
Fireman	Ringeison	Ringeison
Length of Train-Feet	2850 To Gillman 2650 Gillman to Chicago	2670 to Gillman 2490 Gillman to Chicago
Number of Loaded Cars	57 To Gillman 52 Gillman to Chicago	53 To Gillman 48 Gillman to Chicago
Number of Empty Cars	10	14 to Gillman 13 Gillman to Chicago
Kind of Cars	6 Gondolas 6 Refrigerator 47 Box 3 Tank 1 Caboose 1 Test Car	3 Gondolas 58 Box 4 Refrigerator 1 Caboose 1 Test Car

Total No. Cars		
Train Weight-Tons	2549 to Gillman 2313 Gillman to Chicago	2561 to Gillman 2335 Gillman to Chicago
Length of Run-Miles	105.8	110.7
Time on Road	9 hrs. 19 min.	10 hrs. 42 min.
Time of Running	6 hrs. 40 min.	7 hrs. 31 min.
Average Running Speed M.P.H.	15.9	14.7
Weather	Rainy	Rainy
Temperature	50° F.	45°-50° F.
Approximate Average Wind Velocity	19	12
Approximate Average Wind Direction	From 45° west of south	From 25° south of west
Average Draw Bar Pull in Lbs.	15000	13910
Maximum Draw Bar Pull in --- Lbs.	35250 185 lb. boiler pressure. Throttle open 5/8 Reverse lever in notch no 8. Speed 6.7 M.P.H.	36500 190 lb boiler pressure. Throttle wide open Reverse lever in notch no. 15 Speed 1.8 M.P.H.
Average Draw Bar Horse Power	636	546
Total Water Used Lbs.	182350	218515

Water Used Per Hour of Actual Running Time Between Initial and Final Water Readings.	26237	26704
Steam Used Per Draw Bar Horse Power Hour	41.3	48.9